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MAGNETIC AND ELECTRICAL PHENOMENA IN OCEANS AND SEAS

Item of Interest

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SOURCE: Shuleykin, V. V. Magnetic and electric marine phenomena IN HIS: Ocherki po fizike morya (Studies on marine physics). Moskva, Izd-vo AN SSSR, 1962. 410-466.

This study provides a summary of research on geomagnetism and geoelectricity as they occur in oceans and seas. Investigations of geomagnetic and geoelectrical phenomena in oceans and fresh water bodies conducted since 1955 have posed new problems whose solutions require a radical modification or replacement of existing hypotheses.

Several theories exist to explain the self-excitation of the earth's complex electromagnetic field. The theories proposed by Soviet physicist Ya. I. Frenkel' in 1945 and English geophysicist E. Bullard somewhat later are most widely known. Frenkel' hypothesized that the self-excitation of currents takes place in the molten metallic core of the earth. Bullard hypothesized that the relative motions of metallic masses generate the self-excitation of currents. Bullard's hypothesis does not explain the constant component of the magnetic declination or the peculiar properties of the magnetic field in oceans nor does it account for the 7% demagnetization of the earth during the past century. Consequently, some investigators are returning to Frenkel's theory with the modification made in accordance with recent seismological findings that the innermost metallic core of the earth is solid.

A. T. Mironov, on the basis of numerous recordings of variations of telluric currents in seas, deduced that the sharply oscillating currents associated with magnetic storms and aurora displays are superposed onto the telluric currents which flow continuously along coast lines. He also deduced on the basis of potential gradient amplitudes that oscillations in the density of the telluric current conform to changes in the solar corpuscular streams.

Shuleykin asserts that the electromagnetic method of measuring the velocity of ocean currents cannot be applied universally because its use is practical only in oceanic regions where the total planetary field of telluric currents does not mask the field of Faraday currents in a moving body of water. The electromagnetic method used by American scientists for measuring the current velocities in the Gulf Stream cannot be applied in the North Atlantic, where the telluric currents are greatly influenced by aurora and magnetic storms whose interferences are difficult to compute. The application of the electromagnetic method is also precluded near the equator, where the velocities

of ocean currents are fairly high but the vertical component of magnetic intensity is small, so that the relative importance of interferences superposed onto the telluric currents increases.

In 1956, Yu. G. Ryzhkov and F. A. Gubin on an expedition in the Indian Ocean discovered that the density of telluric currents increases in the deeper layers of water. This discovery was corroborated in 1957 by the findings of the *Sedov* in the narrowest portion of the Atlantic between Africa and South America and the *Mikhail Lomonosov* at other points in the Atlantic. This phenomenon, however, was not detected in relatively small, fresh-water Lake Baykal, where the current density remained constant between the 1000-m depth and the bottom.

To illustrate that the amplitude of the current oscillations is at a maximum along coastlines, the author compares the "shore effect" in a circular ocean to the "skin effect" with respect to alternating current in a wire. This effect has been noted even along the shores of Antarctica near Mirnyy. Nothing is known about the origin of the huge whirl of telluric currents in the ocean around Europe, Asia and Africa or the Americas and Australia.

An interesting type of investigation now in progress is the submerging of compasses in specially designed housings into deep oceanic waters to study actual changes in the magnetic field with depth. The apparatus, which is described and illustrated in the text, includes an automatic registering device. Probings by the *Mikhail Lomonosov* between Africa and South America in 1959 indicate that the electric current penetrating oceanic waters actually helps to create the magnetic declination. To depths of less than 1000 meters the magnetic declination changes very little, but below this depth a sharp decrease is noted. At a depth of 4200 meters the declination is 24° less than at the surface. Later probings verified the hypothesis that the magnetic field of telluric currents in the ocean helps to create a latitudinal component of the intensity of the geomagnetic field, i.e., of the magnetic declination. On the basis of the data obtained it may be assumed that about one-half of the latitudinal component is generated by telluric currents in the ocean.